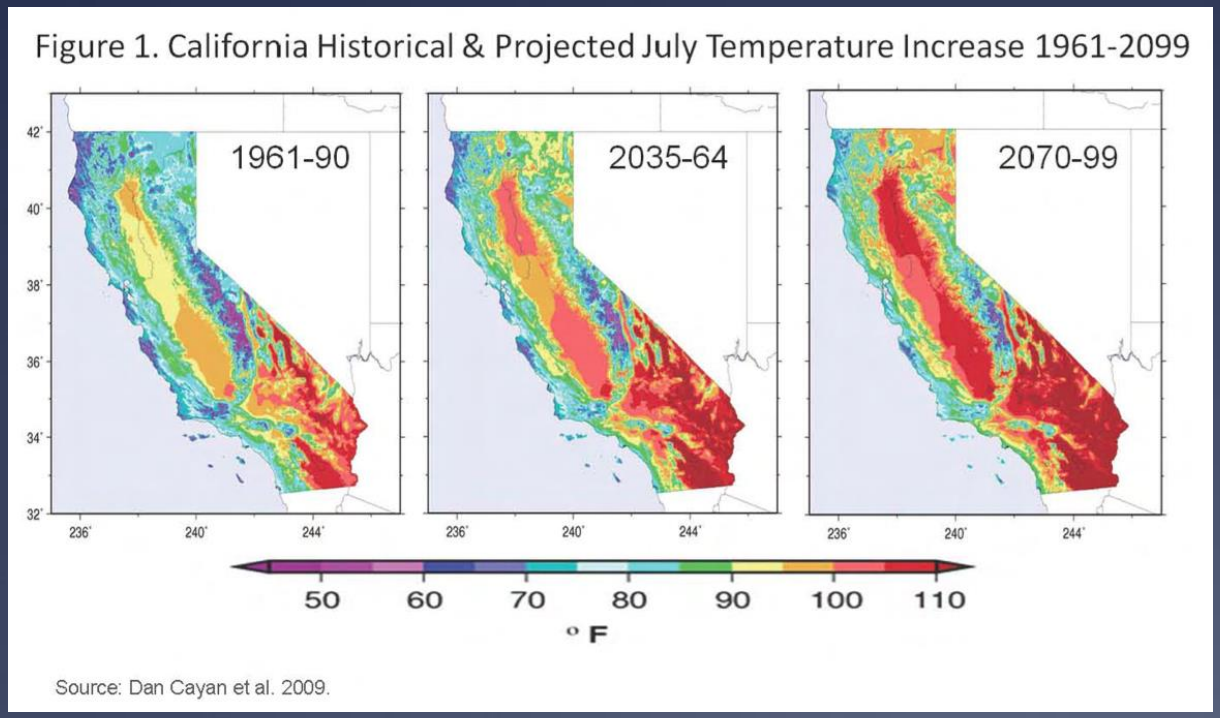
Groundwater and Climate Change

Ruth Langridge
University of California, Santa Cruz

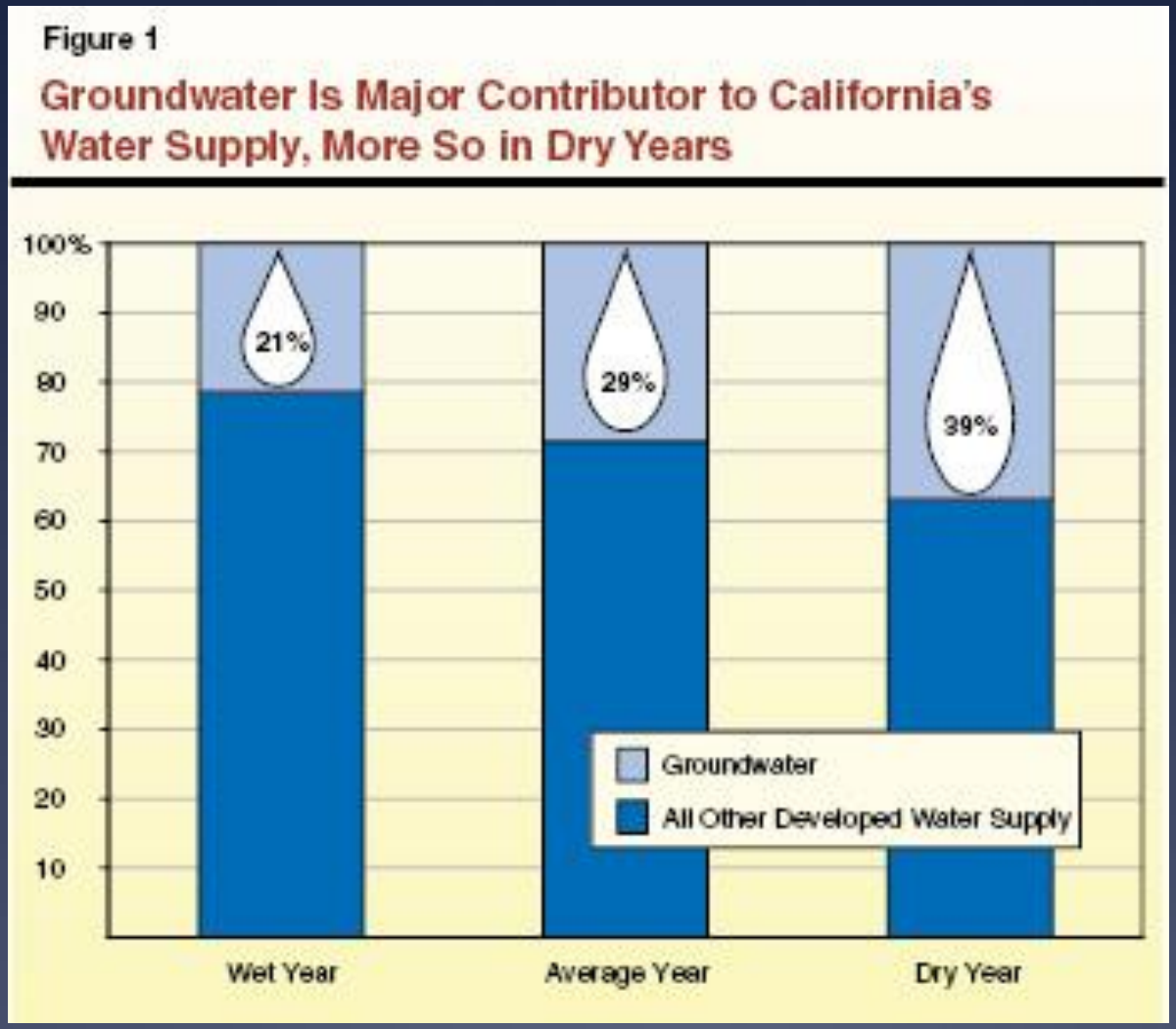
Climate Change Impacts Affecting Water:

Higher temperatures
Diminished snowpack
Changes in extremes
Changes in surface run off
Rising sea levels



Less Freshwater Availability

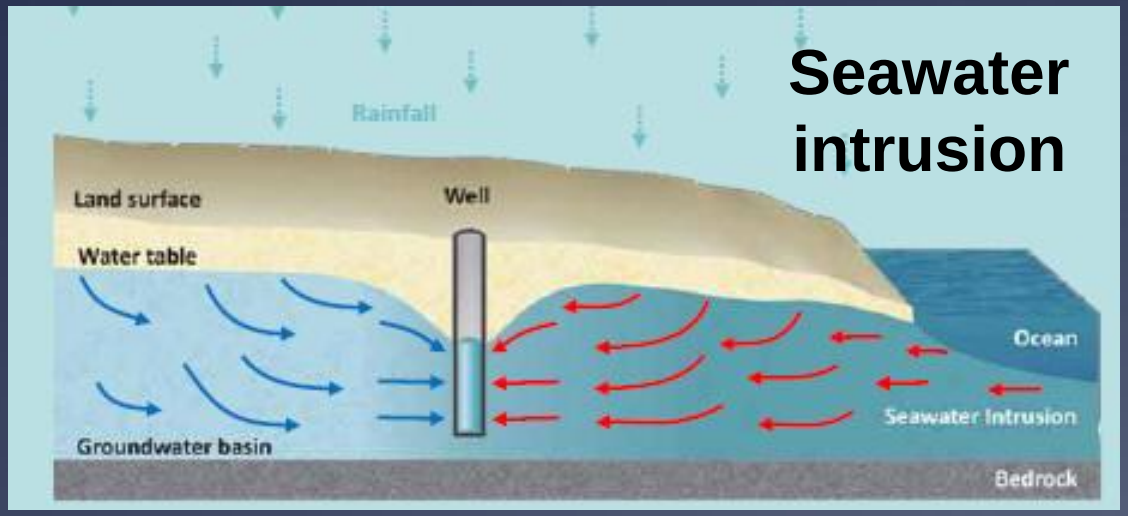
Groundwater pumping will likely increase to compensate for reduced surface supplies

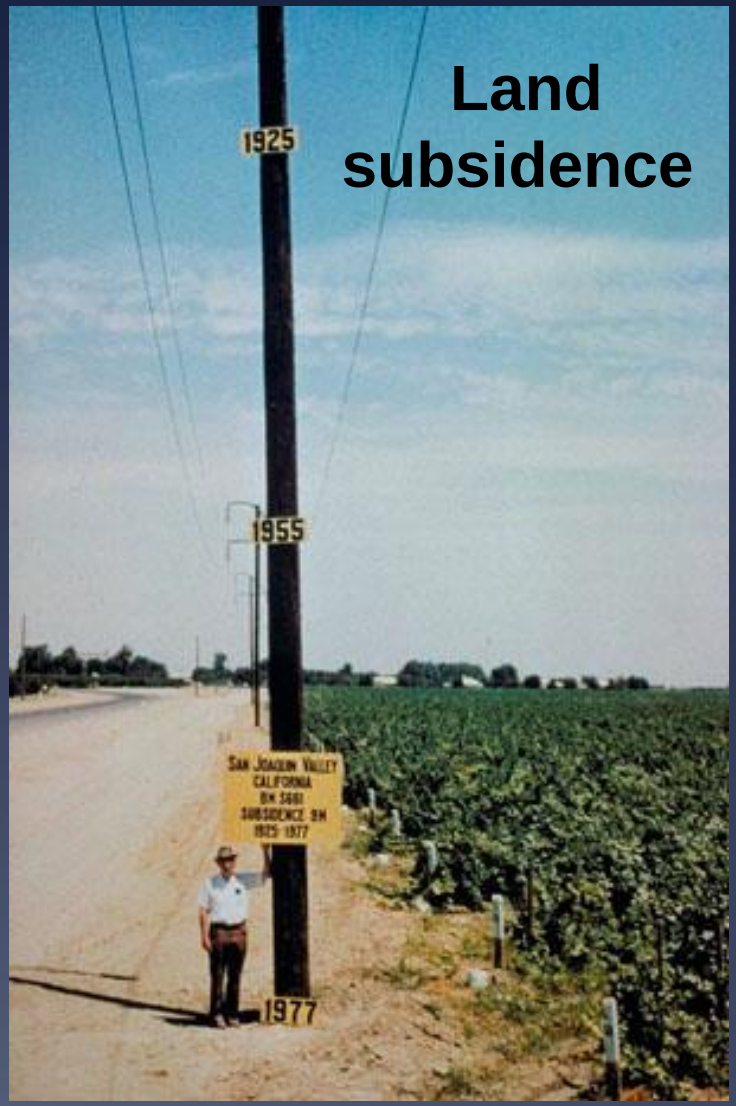


Legislative Analysts Office (2010)
http://www.lao.ca.gov/reports/2010/rsrc/groundwater/groundwater_032410.aspx

Climate change will exacerbate ongoing problems with groundwater including:

Overdraft
Water quality degradation
Surface streams going dry





How can we manage our groundwater more sustainably?

Legal – Institutional Context for Groundwater Management

No State Permit System for Percolating Groundwater

Overlying Landowners

Correlative Rights Doctrine

Local Agencies are
Primary Managers of Groundwater

Local Management

Agencies - Districts:

Fix & collect fees, regulate & monitor extraction & overdraft, establish recharge programs

City and County Ordinances:

Baldwin v County of Tehama, (Ct. App 1994)

May adopt ordinances to manage groundwater

Adjudicated Basins

Mandates to reduce overdraft

Federal

Endangered Species Act

State

1992 “AB 3030” GMPs (voluntary)

2009 (SBX7 6) Groundwater Monitoring

Reasonable Use Doctrine

Public Trust Doctrine

CA Water Code

Unsettled Groundwater Legal Issues

DEFINITION OF GROUNDWATER

Permit required - Surface waters & underground streams "flowing through known and definite channels"

No permit required - Percolating groundwater

What is the definition of a "known & definite channel"?

PUBLIC TRUST DOCTRINE

State has continuing duty to protect PT values where feasible

If applicable to streams that feed Mono Lake,

is PTD also applicable to groundwater that "feeds" a surface waterbody?

Climate Change, Groundwater and Drought

Climate Change and Water Supply Security:
Managing Groundwater to Increase Drought Resilience

PI - Ruth Langridge*

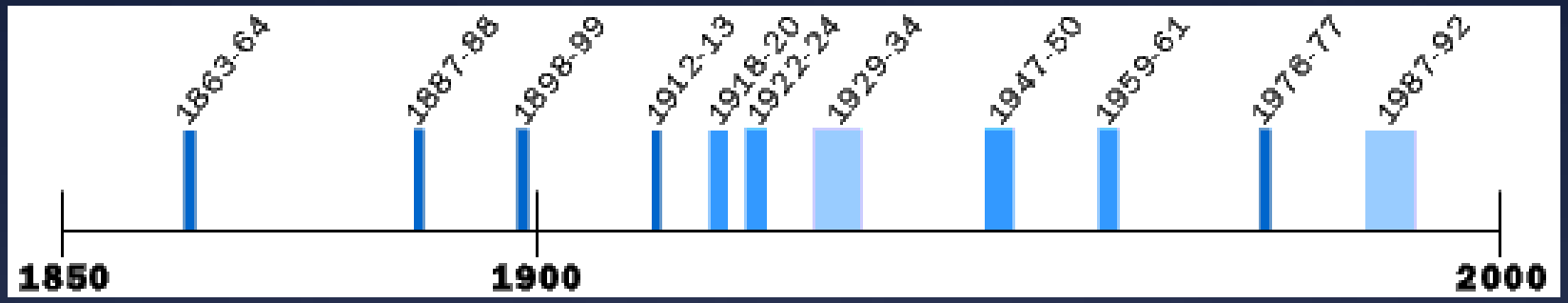
Co-PIs – Nigel Quinn,* ***Ben Crow,**** *Andrew Fisher**

Graduate Students - K. Rudestam, Abigail Brown, Peter Towbin,
*Bruce Daniels, Andrew Racz**

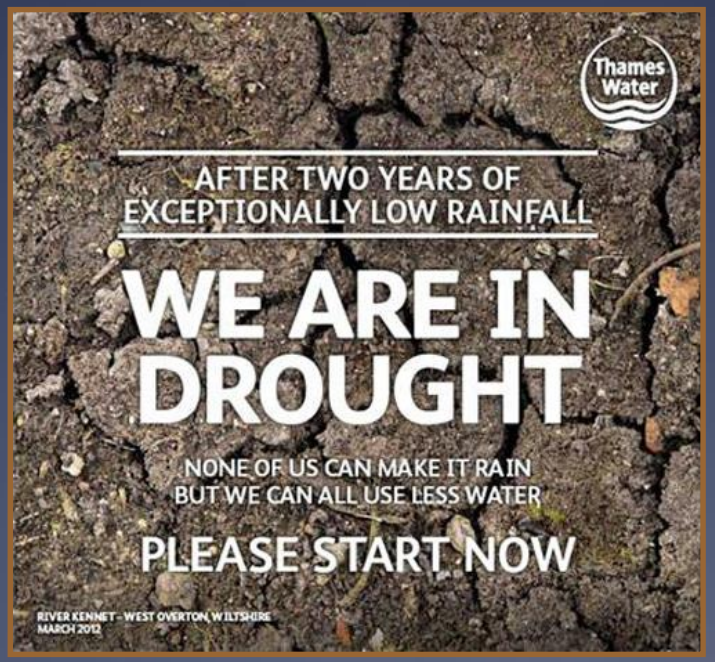
Advisors – Marcelle DuPraw,** ***Emmanuel Asinas******

University of California, Santa Cruz, **University of California, Merced and LBL, ***Sacramento State Center for Collaborative Policy,**California Department of Water Resources*

California Droughts: 1850-2000



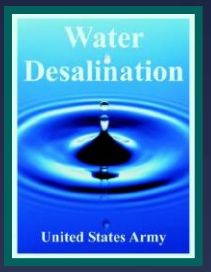
To reduce drought vulnerability, the primary strategy is to curtail water use ***after*** a drought occurs



And Generate More Supply

Recycled water

Desalination



Caution!

Increase Water Supply During Dry Years

↓

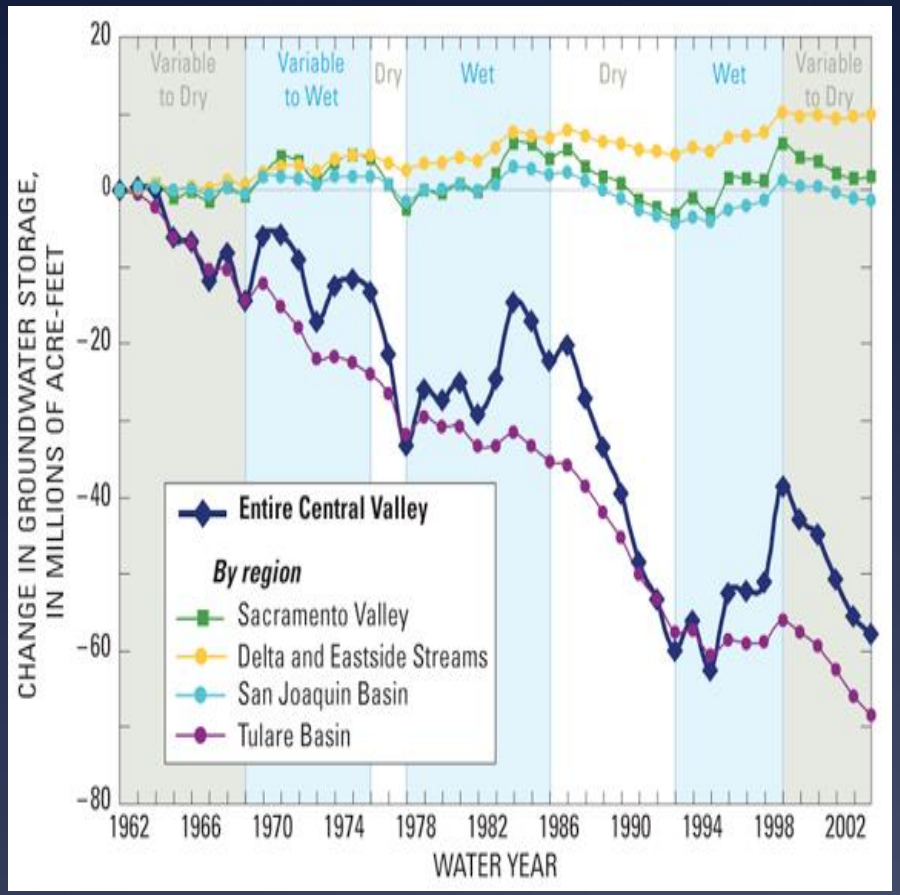
In Wet Years, Extra Water Can Lead to More Development

↓

No Reserve
and
Hardening of Demand Strategies

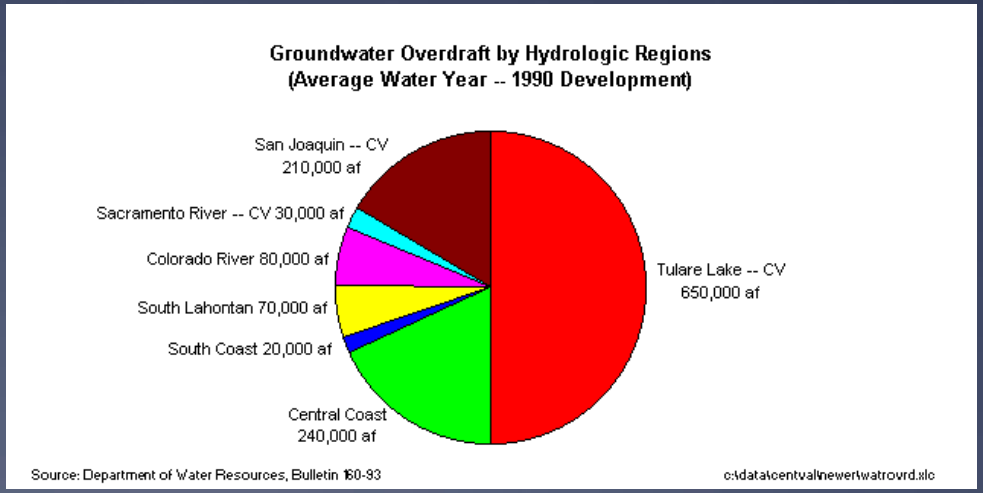
↓

Increased Vulnerability in Future Droughts



Continued loss of stored groundwater in the southern part of the CV.
Since ~1960, groundwater has been depleted by almost 60 million acre-feet

http://pubs.usgs.gov/fs/2009/3057/



How can California communities *proactively* adapt to extreme droughts under climate change?

"..it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. It was always that way. John Steinbeck

Local Groundwater Drought Reserves

Serve as a buffer during an extreme drought

Less energy intensive

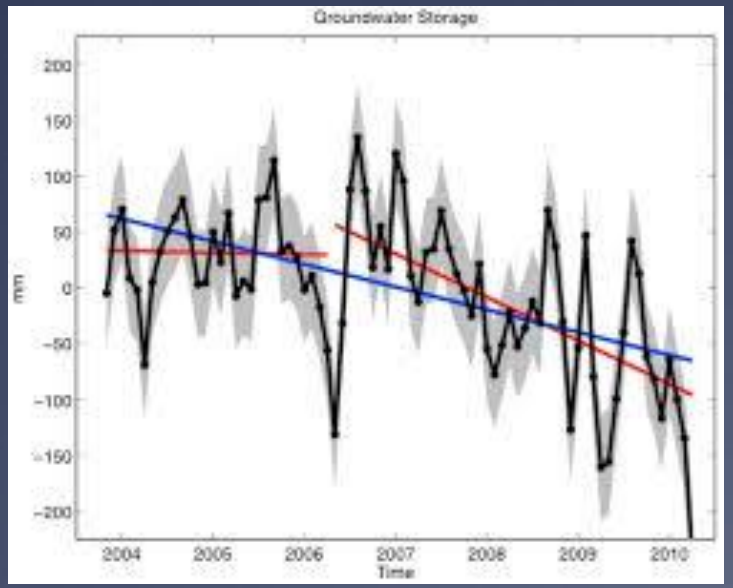
Reduce overdraft impacts

Support groundwater dependent ecosystems

How does our approach differ from current groundwater banking?

Local sources of water - Stored locally
Used for local communities

Focus is on recovering groundwater levels to avoid further declines during a drought



Central Valley-Groundwater Storage Trends
10/04 - 10/09
J. S. Famiglietti et. al. (2010)

Our Approach

General and site-specific factors that affect drought resilience

Case Studies

Factors that motivate regions with long-term overdraft and conflicts over water to proactively address drought

Impacts and financial costs of a groundwater drought reserve versus a no-reserve option

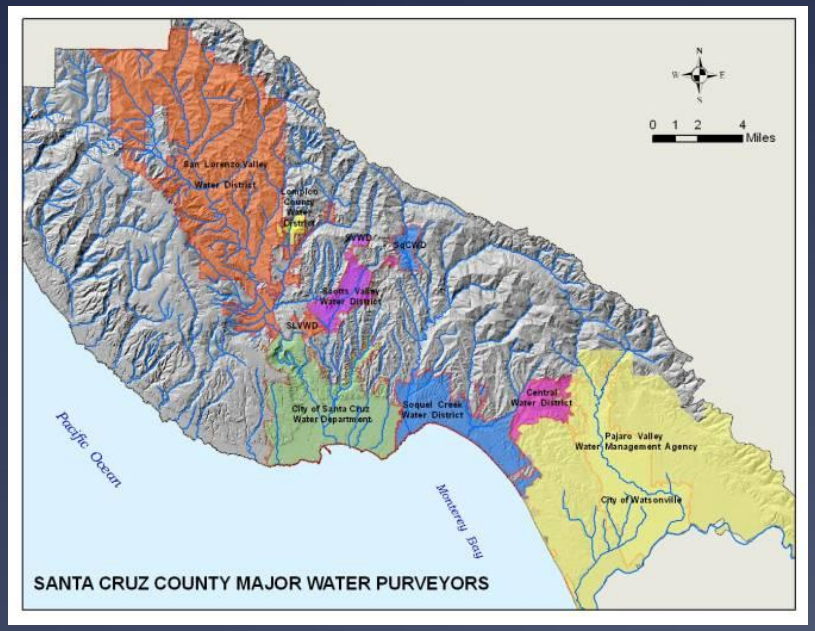
Tools to assist regions in determining thresholds and other parameters for a local groundwater drought reserve

Central Coast

North Coast

Scotts Valley Water District

Pajaro Valley Water Management Agency



Santa Cruz Water Department

Soquel Creek Water District

Sonoma County Water Agency

Physical Context

Sources of water
Condition of groundwater basin

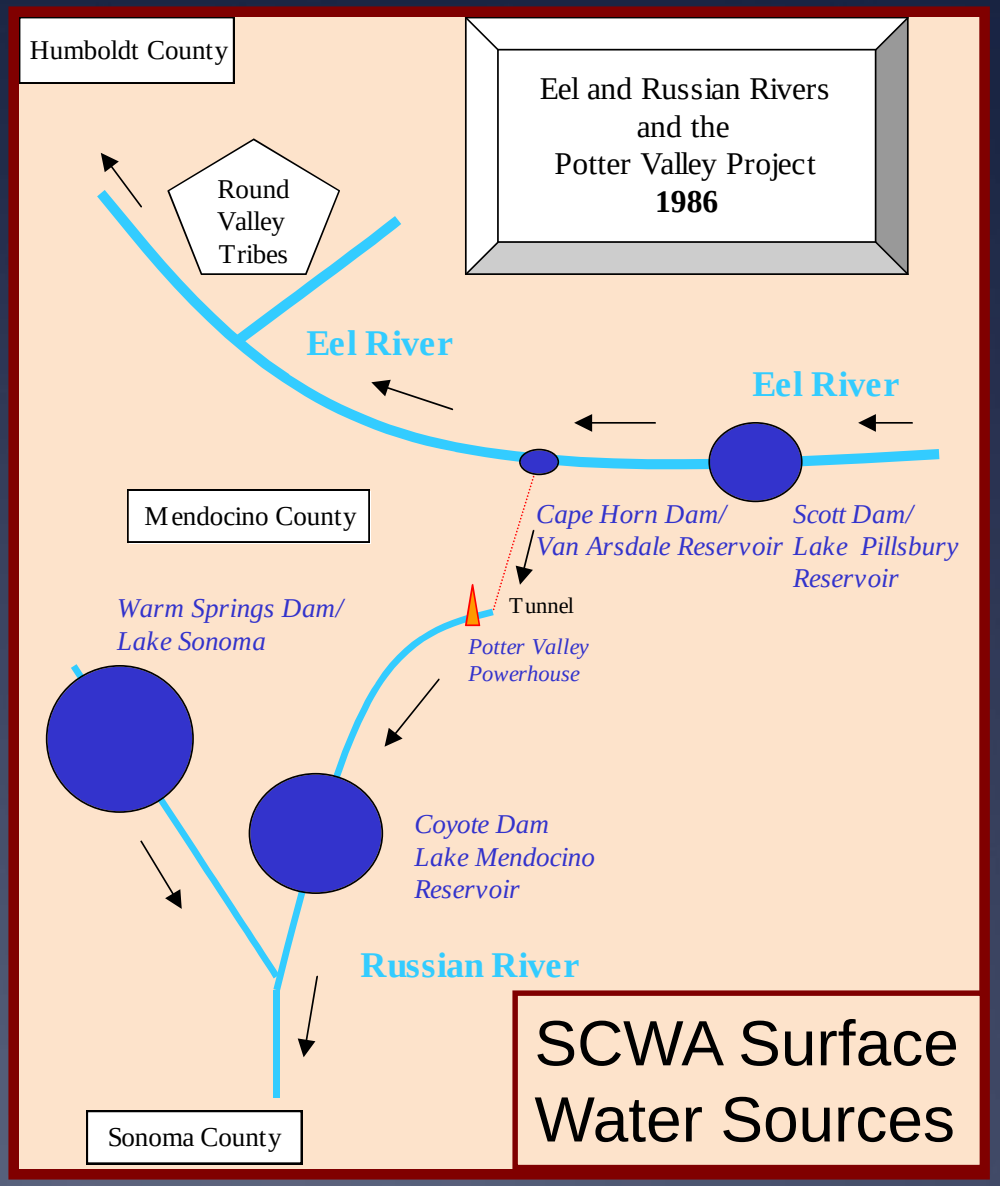
Legal-Institutional Context

Water Rights, Governance

Socio-Political Context

Stakeholder conflicts
Agency/Board leadership

Sonoma County Water Agency



Russian River Endangered Species

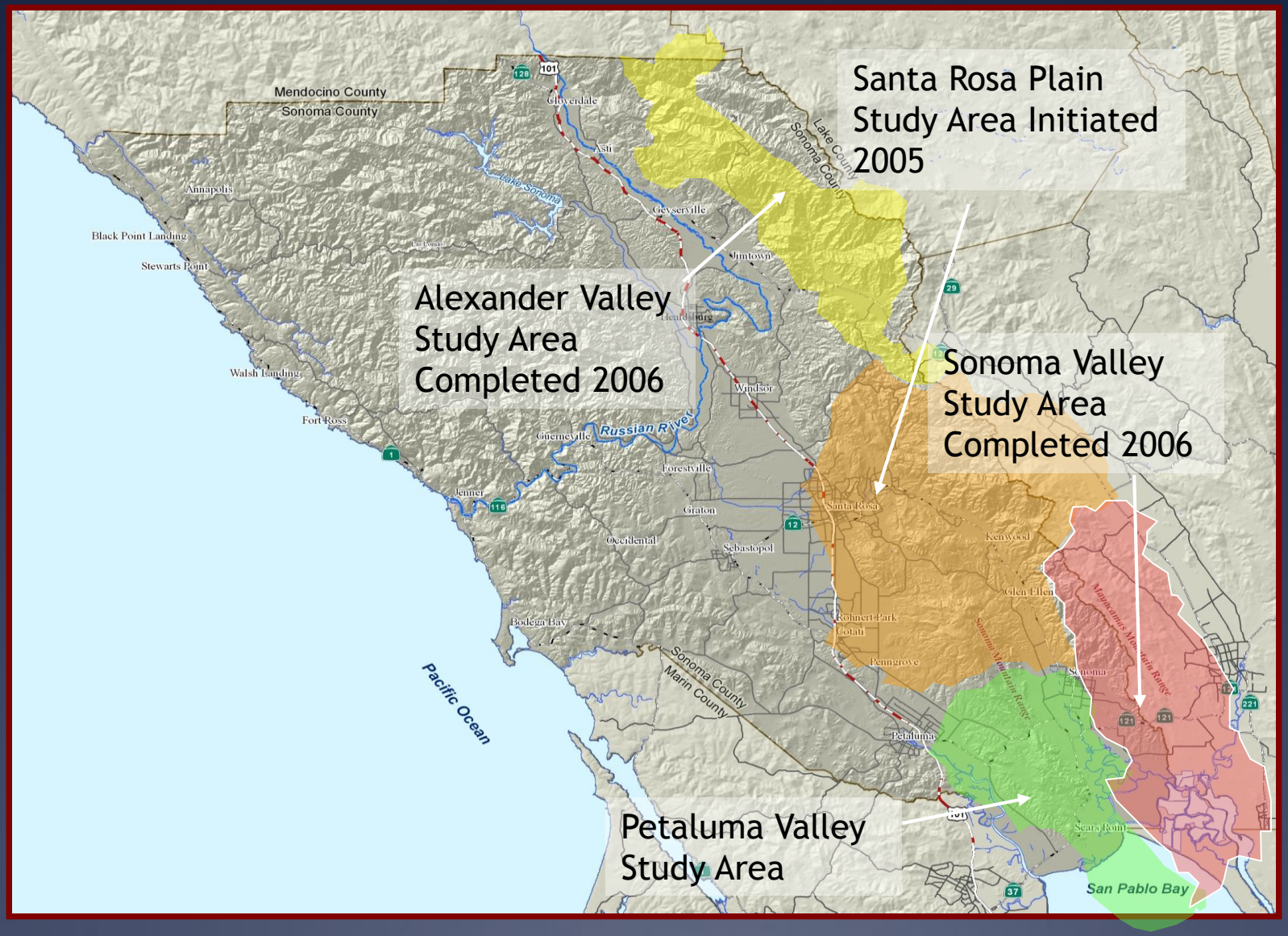
Coho salmon
(Endangered)

Chinook salmon
(Threatened)

Steelhead trout
(Threatened)

1996	Central California Coastal ESU of Coho Salmon
1997	Southern Oregon/Northern California Coast ESU of Coho Salmon
1999	California Coastal ESU of Chinook Salmon
2000	Northern California Steelhead ESU

SCWA Groundwater Basins



Sonoma Valley Groundwater Management Program

2006: Convened Stakeholder Group

2007: Groundwater Management Plan

Adopted by:

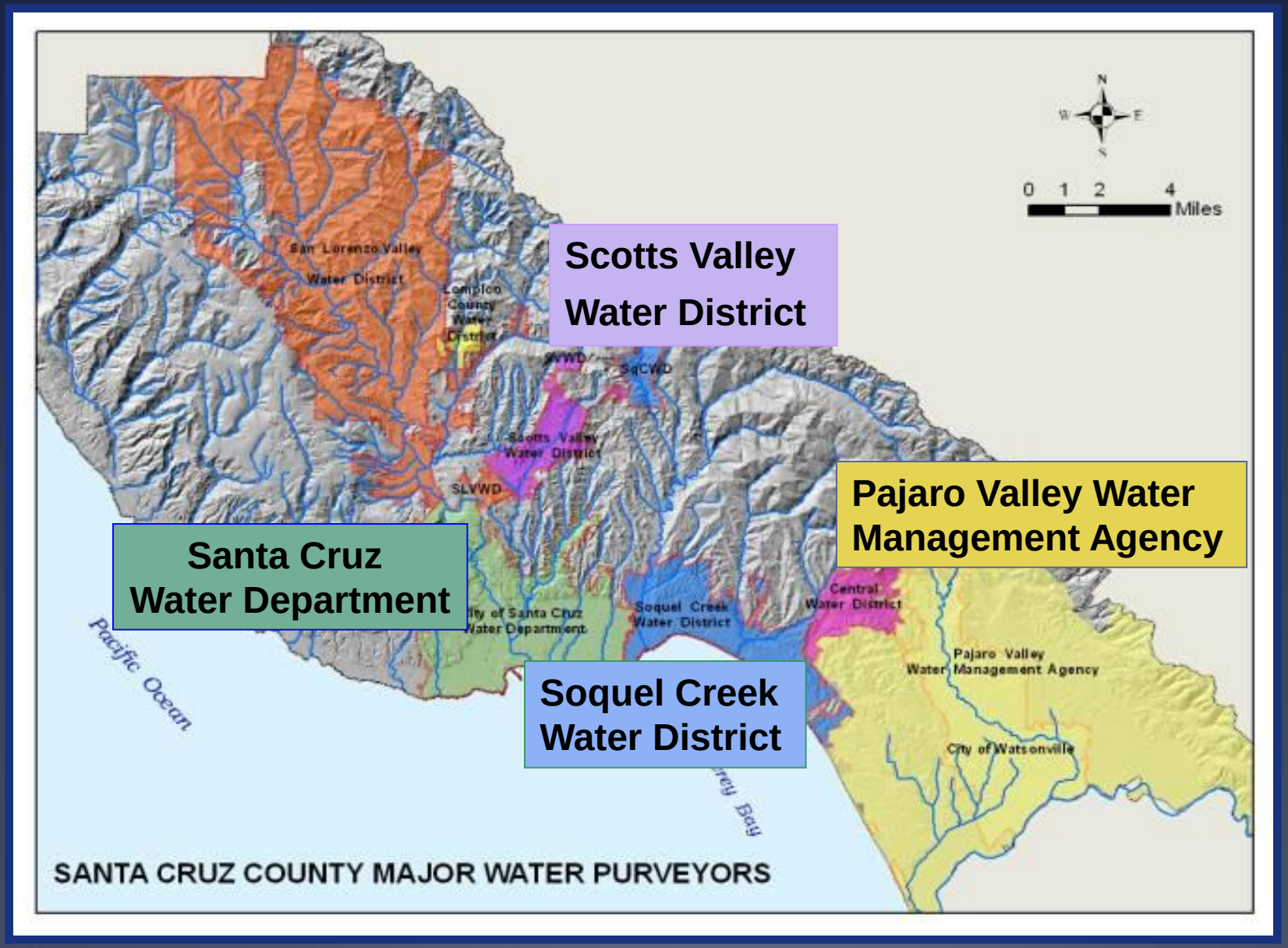
Sonoma County Water Agency

City of Sonoma

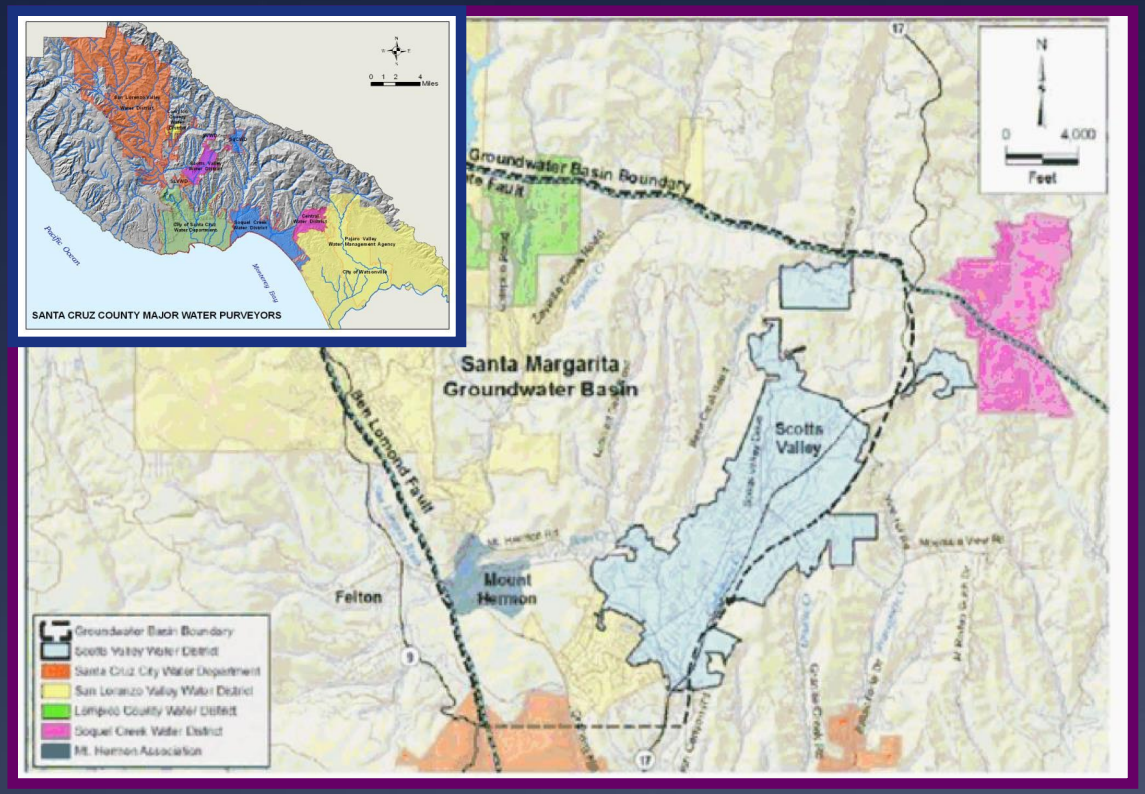
Valley of the Moon Water District

Non-Regulatory and Collaborative Process

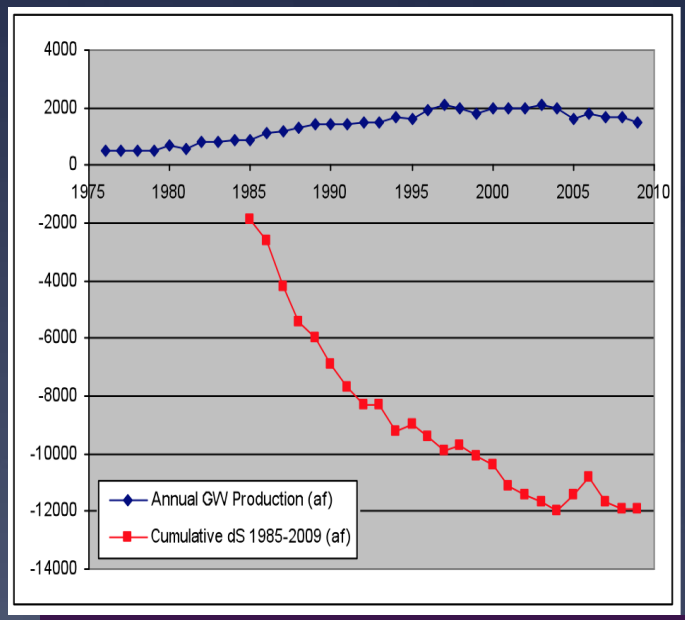
Central Coast Study Areas



Scotts Valley Water District



Groundwater from
The Santa Margarita
Groundwater Basin
Is sole source of
potable water for SVWD

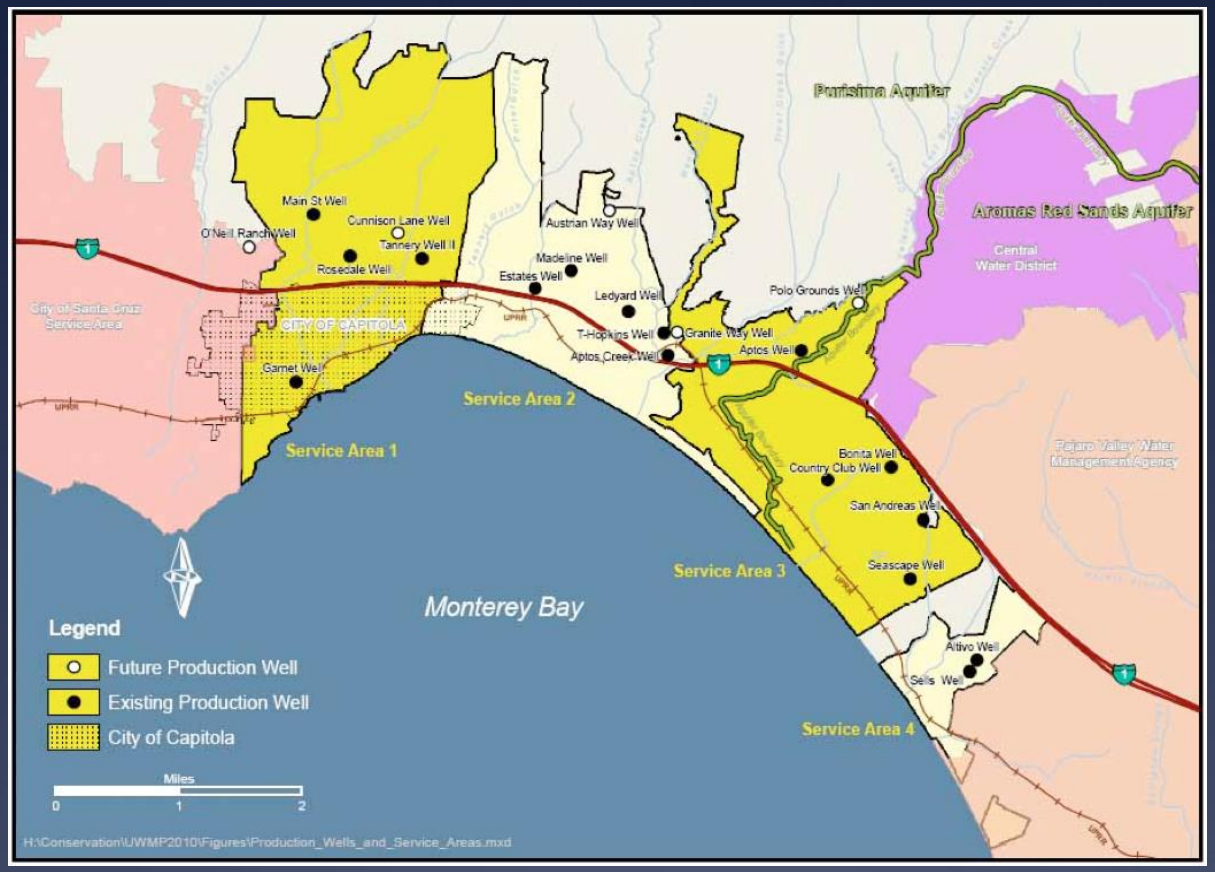


1975-2010 : Change in
GW Production & Storage

Strategies to Reduce
GW Production

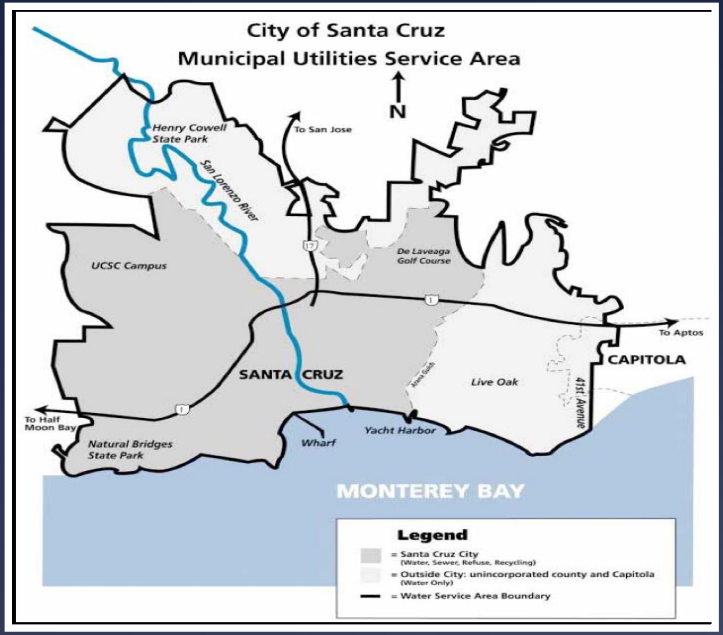
Water Conservation
Recycled Water
Gray Water
Rebates

Soquel Creek Water District

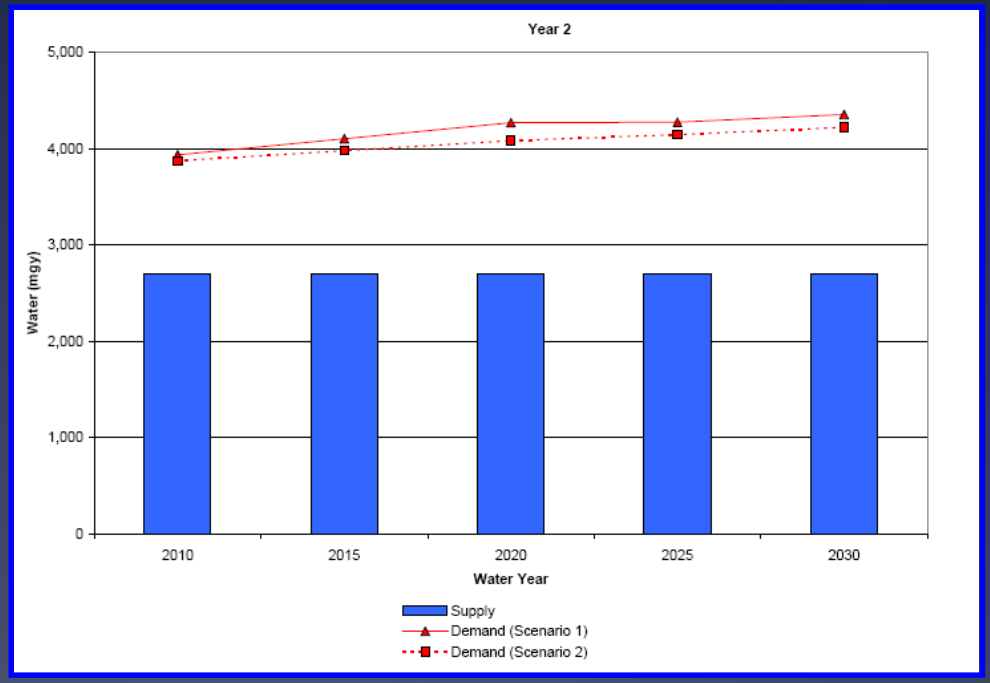


The Purisima and Aromas Red Sands Aquifers provide all of SqCWDs water and are at risk for seawater intrusion

Santa Cruz Water Department



Multiple Dry Water Years



Water Sources

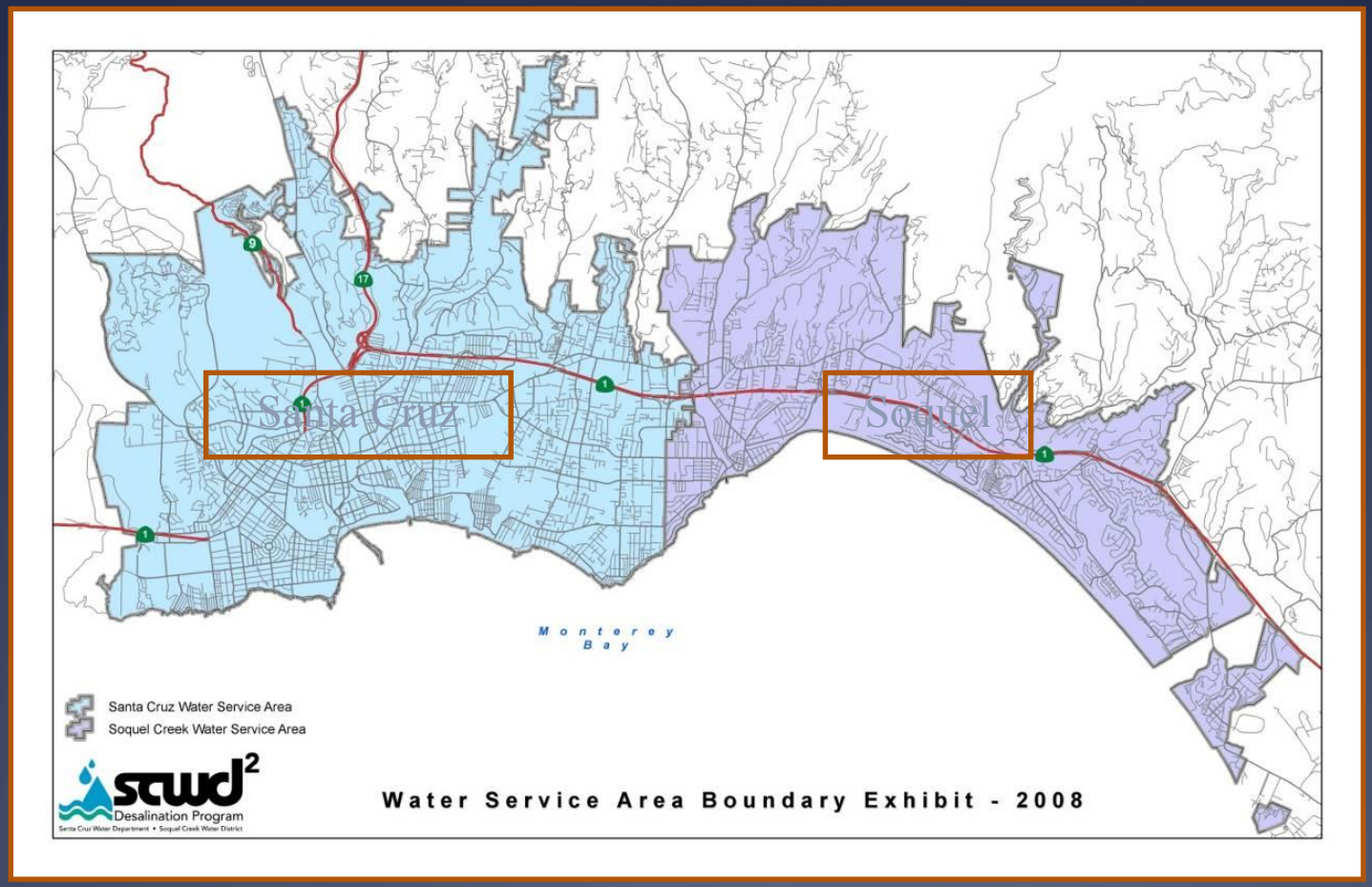
Rivers, streams
and reservoirs 66%
Groundwater 4%

Endangered Species Act

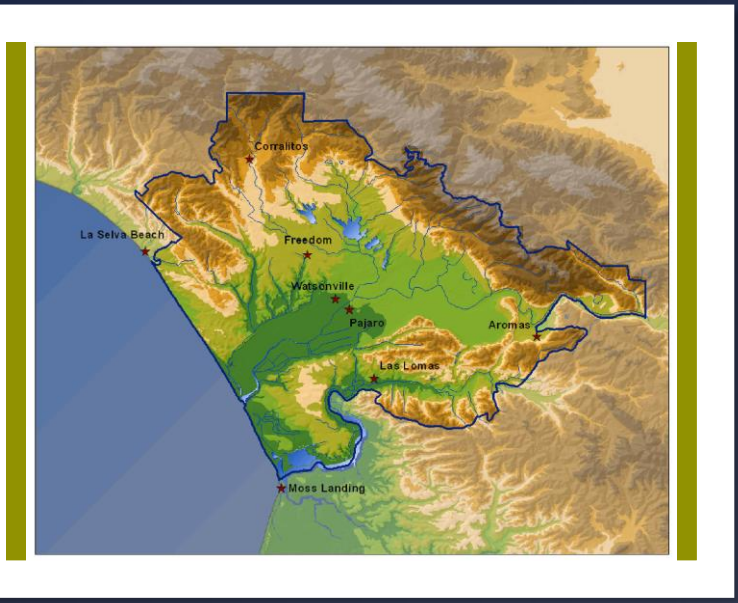
Need to reduce existing surface water diversions for endangered salmon and steelhead

Drought Reserve Project

Collaboration Between
Santa Cruz Water Department
and Soquel Creek Water District



Pajaro Valley Water Management Agency



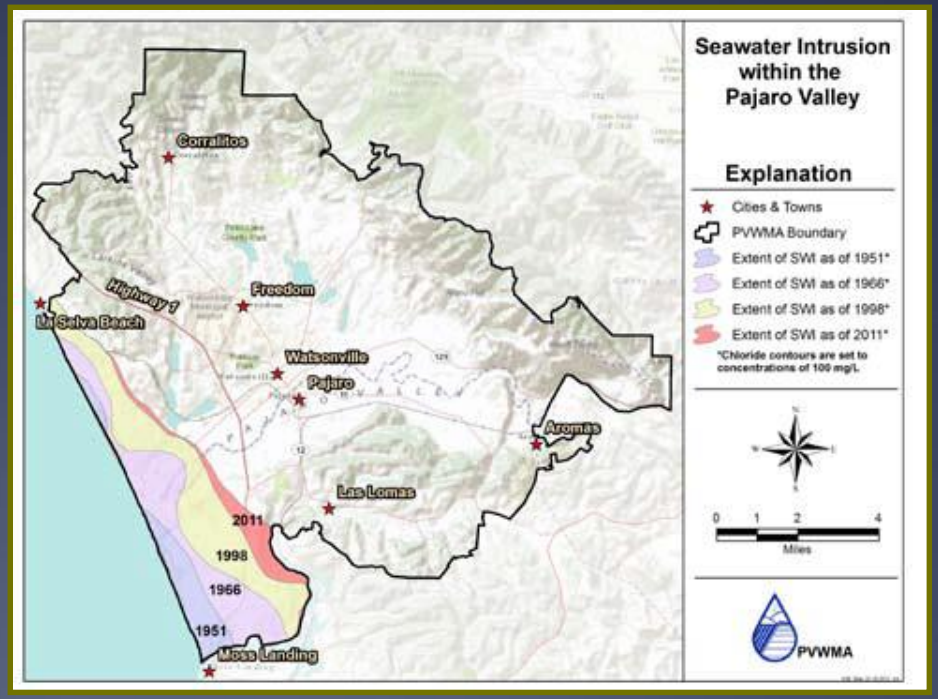
Seawater Intrusion

~ 1,900 afa in Upper & Lower Aromas aquifers

1998-2011 - 12% increase

Total intruded area has increased ~ sevenfold fold since 1951

Largest increases correspond with periods of drought

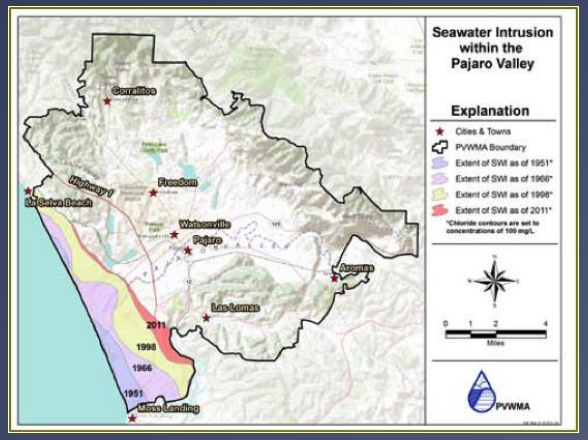


Pajaro Valley Water Management Agency

Present Strategies to Reduce Overdraft

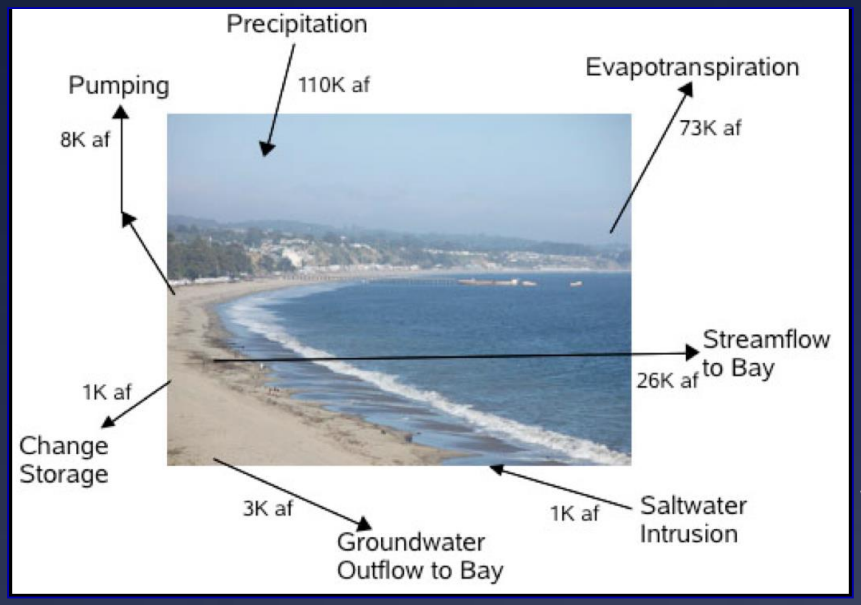
Recycled Water And Recharge Facilities

Stakeholder Conflicts Litigation

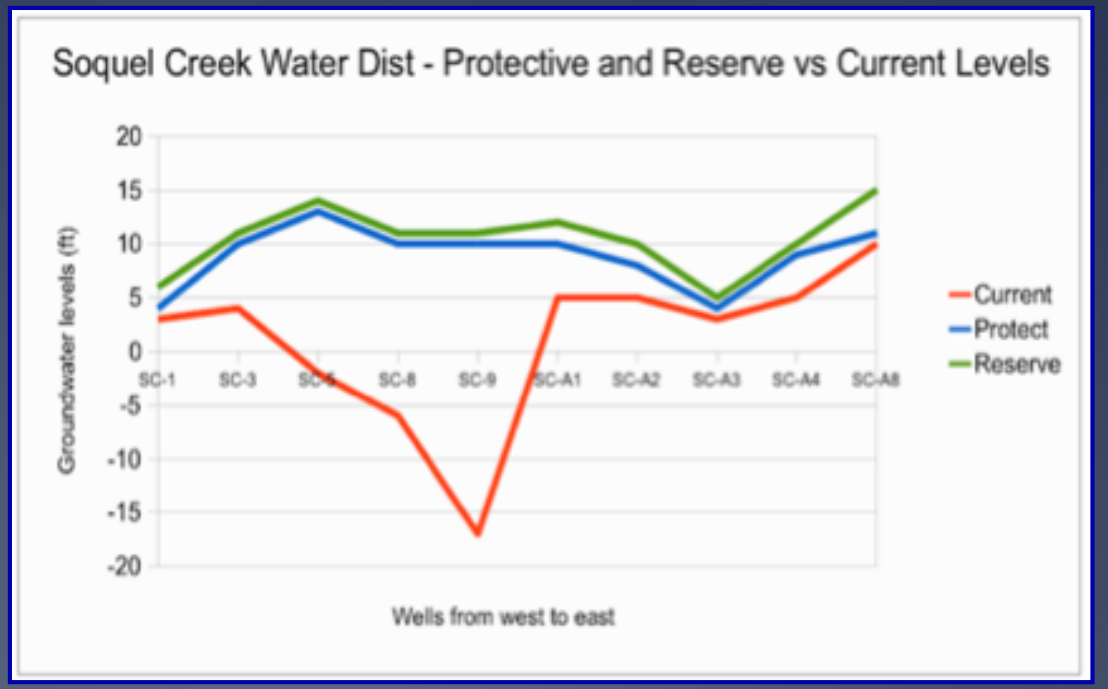


Coastal Distribution System

Calculating a Drought Reserve for Soquel Creek



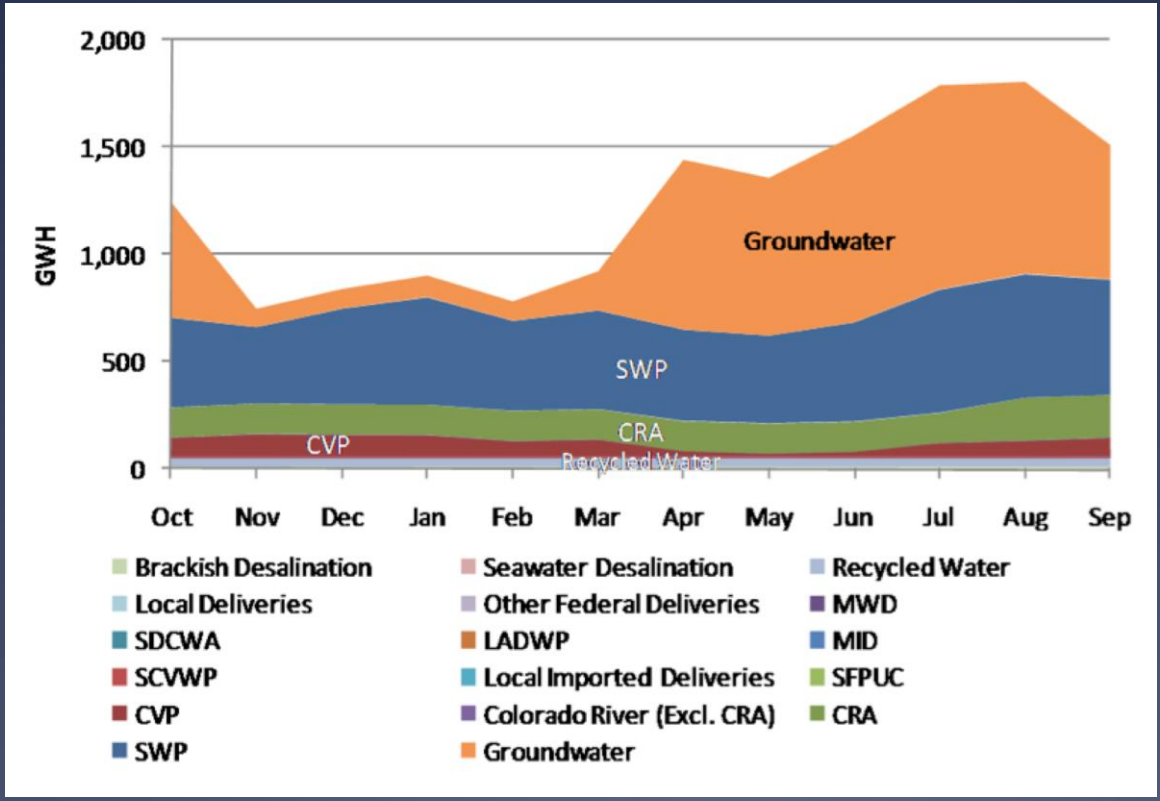
Water Balance Model Soquel Creek
Source: Daniels (2011)
Figures from: SqCWD. 2004 & 2009



Source: Data from Soquel Creek Water District. 2009.
Groundwater level metrics can be converted into acre-feet

Groundwater and Energy Use in California

Groundwater pumping accounts for more electricity use during summer months than pumping for the state's three largest water conveyance systems – SWP, CVP and CRA - combined



What Can the State Do?

California Water Code § 12922

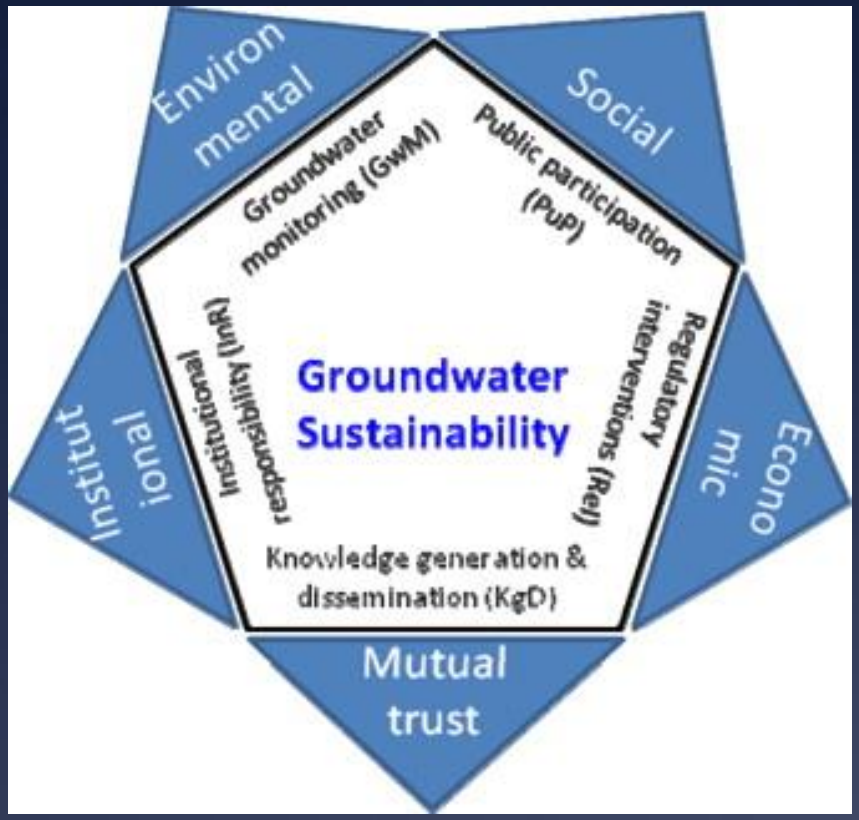
"…the people of the State have a primary interest in the correction and prevention of irreparable damage to, or impaired use of, the ground water basins of this State caused by critical conditions of overdraft, depletion, sea water intrusion or degraded water quality."

California Constitution: Article X, Section 2

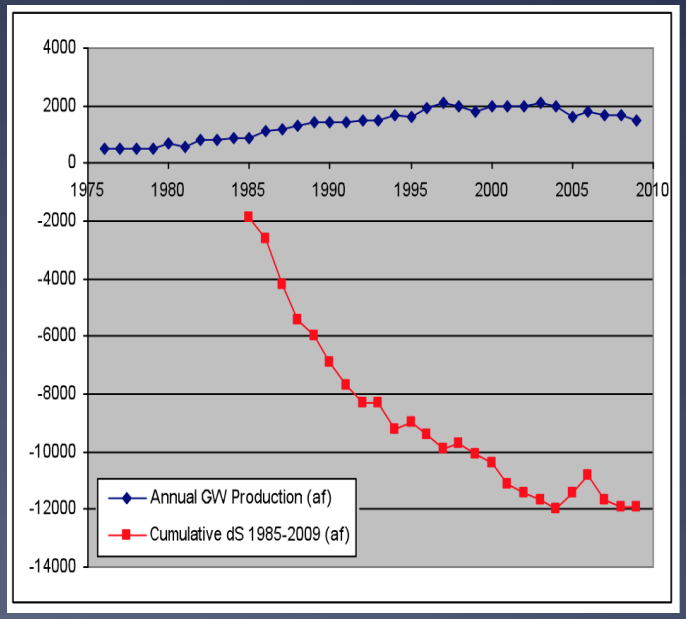
….the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented…... The right to water or to the use or flow of water …. shall be limited to such water as shall be *reasonably required* for the beneficial use to be served*…..*

Water Code- Section 275

The department and board **shall** take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state



A framework for measuring groundwater sustainability
Pandeya, et. al. 2011



Groundwater monitoring
Knowledge generation & dissemination
Regulatory interventions
Public participation
Institutional responsibility

Sustainable Groundwater Management

Sustainable thresholds for water level drawdown & water quality

Water quality and water level monitoring and assessment capable of determining if thresholds are being met

Governance structures with management mechanisms to prevent impacts before they occur & ensure that groundwater level and quality thresholds are met over the long term

Funding to support monitoring & governance/management

Oversight and enforcement in basins where ongoing management efforts are not protecting groundwater

State Water Board Groundwater Workplan Concept Paper

http://droughtreserves.ucsc.edu/